M E M O R A N D U M

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SUBJECT: **South Florida Water Management Model V5.0 improvements with respect to modeling of the Lake Okeechobee Service Area and Lake Okeechobee inflow basins.**

Introduction

The South Florida Water Management Model (SFWMM) simulates Lake Okeechobee (LOK) and several of its surrounding areas as lumped hydrologic basins (in contrast to the distributed 2-mile by 2-mile grid system used in the majority of the model domain). The LOK water budget is handled using the modified-delta storage method as described by Trimble (1986). This method makes use of a "modified-delta storage" (MDS) term to account for the influences on LOK that are not explicitly handled in the SFWMM. While several basins (e.g. C43, C44, etc.) have historically been modeled explicitly, recent District planning efforts in combination with clarifications in the Supply Side Management (SSM) policy for drought management of LOK, have established a need for explicit or improved representation of a selection of Lake Okeechobee Service Area (LOSA) and LOK inflow basins in regional modeling efforts. As a result, several changes were incorporated into Version 5.0 of the SFWMM that impact the LOK water budget and the MDS term. This memo will review, on a basin by basin basis, changes and improvements made to the modeling of selected LOSA and LOK inflow basins within the SFWMM. Additionally, internal enhancements to SSM implementation and modifications to the structure/content of model output will be detailed. Figure 1 and Figure 2 graphically illustrate the changes observed between SFWMM pre-V5.0 and SFWMM V5.0 and can be used as reference for the subsequent discussion.

Caloosahatchee / S4 Basins

In versions of the SFWMM before V5.0, the Caloosahatchee (C43) basin was modeled as a separate "bucket" from LOK and a demand/runoff time series was required in the dmdro.dss input file to the model. A variety of methods had been used to quantify this time series including historical data and the AFSIRS/WATBAL model (Flaig 2000). In contrast, the S4 basin was handled as an interior boundary condition to LOK. The control volume for MDS calculation included S235, effectively lumping the S4 basin into the LOK water budget. In order to account

for effects in the S4 basin, demands were pro-rated from Miami Canal Basin demands and runoff was read in from the dmdro.dss (as historically estimated data with 83% always being routed to Caloosahatchee basin via S235).

In order to obtain more consistency in SFWMM V5.0, the S4 basin is treated in a manner similar to the C43 – as an external "bucket" to LOK. An additional level of complexity is also added due to the fact that a physical connection additional to S235 exists between the S4 and Caloosahatchee basin via the 9-mile canal (to Lake Hicpochee). In order to give users the flexibility to model impacts due to this connection, the S4 Basin is now modeled as the combination of two separate basins: S4_Diston (portion of S4 basin that has a physical connection to the C43 basin) and S4_Other. Input options in the model_definition_input.dat file give flexibility in modeling the interaction between the S4 basin and the Caloosahatchee Basin via both S235 and the 9-mile canal. Demand/runoff time series are also now required in the dmdro.dss for CALOOS, S4DISTON and S4OTHER tags. These time series are estimated using the V3.0 AFSIRS/WATBAL model (Wilcox 2003). In order to be consistent with the redefined control volume for MDS calculation, the program used to calculate MDS was updated to remove S235 from the computation and include a historical estimate of total S4 basin demand/runoff effects on LOK.

Lower and Upper Istokpoga Basins

In SFWMM V5.0, the Lower Istokpoga Basin is now split into two basins for improved performance (as opposed to the previously existing lumped LKTIPG term). These basins are defined as: Lower Istokpoga Above Brighton (ISTOKPAB) and Lower Istokpoga Below Brighton (ISTOKPBB). This change is necessary due to the fact that the Lower Istokpoga Above Brighton basin is subject to the combined conveyance limitation of the G207 and G208 pump capacities (270cfs). These pumps serve both the Brighton Seminole Reservation and the agricultural land above S71/S72 and below S70/S75. In the SFWMM, Brighton Tribal demands have first priority in water supply deliveries. Unmet demands in the Lower Istokpoga Above Brighton basin accrue from one time step to the next until sufficient conveyance exists to make deliveries. Demand/runoff time series (estimated using AFSIRS/WATBAL V3.0) are now required in the dmdro.dss for these basins.

The Upper Istokpoga Basin (above S70 and S75), while not part of the Lake Okeechobee Service Area, does contribute runoff into LOK via S70/S75 through S71/S72. This volume is made up of primarily upper basin runoff from both irrigated and non-irrigated lands in conjunction with some contribution from flood control releases out of Lake Istokpoga. In order to quantify the historical contribution of the Upper Istokpoga basin to LOK (UISTLK) term in SFWMM V5.0, historical data for the S70, S71, S72, and S75 structure was collected from the DBHYDRO database. To account for lag effects between releases at the upstream structures of S70/S75 and releases at S71/S72, a monthly volumetric analysis was performed. UISTLK contribution was quantified as the minimum of monthly combined S70/S75 and monthly combined S71/S72 flows. This calculation is sufficient to capture the flow-through contribution from the upper basin to LOK. Once the historical monthly volumes were calculated, these volumes were temporally distributed within a given month based on the distribution observed at S71/S72 (effectively on Lake). Periods of missing data - only observed at S70/S75 - in the historical record were patched using a monthly regression dependent on combined current month S71/S72 flow and both current and previous month Lower Istokpoga Basin average rainfall. Regression results are presented in Figure 3. Time series estimates of UISTLK are now required in the flo.dss input file to SFWMM V5.0. The MDS term for V5.0 has been adjusted to account for the addition of the ISTOKPAB, ISTOKPBB, and UISTLK explicit terms.

North / Northeast Lake Shore Basins and TCNSQ

The North and Northeast Lake Shore basins have relatively small areas of irrigated lands compared to several of the other LOSA basins. However, in order to account for all LOSA agriculture as outlined in the updated draft SSM policy (SFWMD 2002), it was necessary to explicitly model these basins in SFWMM V5.0. As a result, AFSIRS/WATBAL V3.0 was used to develop time series data for each basin which was then included in the dmdro.dss input file under the NLKSHORE and NELKSHORE tags.

The addition of the North Lake Shore basin required another change in SFWMM V5.0 related to the previously existing Taylor Creek/Nubbin Slough (TCNSQ) inflow term. NLKSHORE demand/runoff goes through either S133 (only runoff) and/or S193. This is an issue since a portion of the runoff that goes through S-133 is already quantified in the SFWMM as part of the TCNSQ (S133 + S191) inflow term. To avoid any double accounting, an additional term TCNSQ_REV has been added to the flo.dss input file. TCNSQ_REV is essentially the portion of the TCNSQ term which comes from tributary basins upstream of the North Lake Shore. This upstream flow enters the North Lake Shore Basin and is effectively reduced (on days with NLKSHORE demands) or increased (on days with NLKSHORE runoff), resulting in the "at Lake" TCNSQ observed flow. This relationship is graphically illustrated in Figure 4. At run-time, SFWMM V5.0 reads both the TCSNSQ and TCNSQ_REV term and then internally adjusts the NLKSHORE demand and runoff terms to ensure that the LOK budget is correctly accounted and that model output reflects TCNSQ as it is read in from the flo.dss input file. The MDS term for V5.0 has been adjusted to account for both the NELKSHORE explicit term and the portion of the NLKSHORE term not already accounted for in TCNSQ.

The TCNSQ inflow term is calculated as the sum of historically observed flow at S133 and S191. In order to patch missing periods of data in the 1965-2000 period of record, a two-level analysis was performed. First, a monthly volumetric regression analysis was performed correlating TCNSQ flow to S65E flow and both current and previous month Taylor Creek/Nubbin Slough/S133 basin average rainfall. Once the historical monthly volumes were calculated, these volumes were temporally distributed within a given month based on a daily regression model utilizing moving averages of S65E flow and independent average rainfall from the Taylor Creek, Nubbin Slough and S133 basins. These moving averages were selected based on the expected response time associated with each element of the regression model (e.g. rainfall from more upstream basins would have a longer moving average than a more downstream basin). Regression results for the monthly and daily regressions are presented in Figure 5 and Figure 6, respectively. While there is not a very high correlation in the daily regression model and it tends to over-predict low flow events and under-predict high flow events, this is acceptable since its purpose is only to distribute within the volumes predicted by the more reliable monthly regression model.

St Lucie Basin

The modeling of the St. Lucie basin was minimally impacted during the transition to SFWMM V5.0. For consistency sake, the demand/runoff time series included in the dmdro.dss was estimated using the V3.0 AFSIRS/WATBAL model as with the other LOSA basins outside the gridded SFWMM domain. The AFSIRS/WATBAL model was also used to help estimate historical flows at S308 which were then incorporated in the calculation of MDS for V5.0. Previously, the SEALINK model or historical data had been used to estimate St. Lucie basin demands.

SFWMM Internal Enhancements to Supply-Side-Management Implementation

During the 2000-2001 drought, policy issues related to management of LOK under the SSM policy were clarified. In order to be consistent with these guidelines, internal refinements were needed to the SSM subroutines in the SFWMM. These changes were centered on three primary issues: 1) the role of Seminole Tribal demands relative to LOSA demands, 2) the addition of new explicitly modeled LOSA basin demands to the SSM allocation calculation and 3) the placement of the call to the SSM subroutines relative to other policy implementation. The first issue was addressed by taking Tribal demands out of the SSM calculation of LOSA demand (i.e. Tribal demands are not considered as part of LOSA – this is consistent with what was done in the 2000-2001 drought). Although these demands are not part of LOSA, they can still be subject to the SSM cutback fraction, depending on options in the model_definition_input.dat file, and are included as an adjustment to the reference elevation in a manner similar to LEC water supply deliveries. While tribal lands were taken out of the SSM calculation, several additional LOSA basins were added to the calculation of demand in the SSM subroutines. The changes to the SSM demand calculation involved adding S4DISTON, S4OTHER, ISTOKPAB, ISTOKPBB, NLKSHORE and NELKSHORE and removing the now duplicated S4DMD and LKTIPG terms. In addition to being included in the SSM demand calculations, all of the newly added basins were made subject to the cutback fraction calculated by the SSM subroutines. The final issue of policy enforcement order was addressed by updating the code so that the demand used in the calculation of the SSM cutback fraction is now the sum of the supplemental demand <u>on Lake Okeechobee alone</u>. Previously, total supplemental demand in some basins (e.g. before reservoir and ASR deliveries) was used in place of supplemental demand on Lake Okeechobee. This was inconsistent since the SSM calculation of allocation should only consider "on Lake" supplemental demand.

Modification to Model Output

Due to the modifications outlined in the preceding sections, output from the SFWMM was reorganized (or added) into several new output files as listed below.

Pre-V5.0:
daily_losa_dmdro_supply.dat
daily_s4_s236_298d_dmdro.dat

V5.0:
daily_losa_ssm_summary.dat - Overall LOSA SSM information
(Total Supp DMD, cutback fraction, DMD met, etc…)
daily_eaa_summary.dat - EAA information
(Total crop requirements, Supp. DMD, Runoff, etc.)
daily_losa_other_summary.dat - Information for basins outside EAA, C43 and C44
(DMD, DMD Met, Runoff)
daily_tribal_summary.dat - Seminole tribal information
(Big Cypress, Brighton and Hollywood DMD and DMD met)
daily_c44_basin_bud.dat - Additional column for original supplemental demand before reservoir and/or ASR contributions
daily_c43_basin_bud.dat - Additional columns for original supplemental demand before reservoir and/or ASR contributions and before the interaction with the S4 basin (S235, Diston)

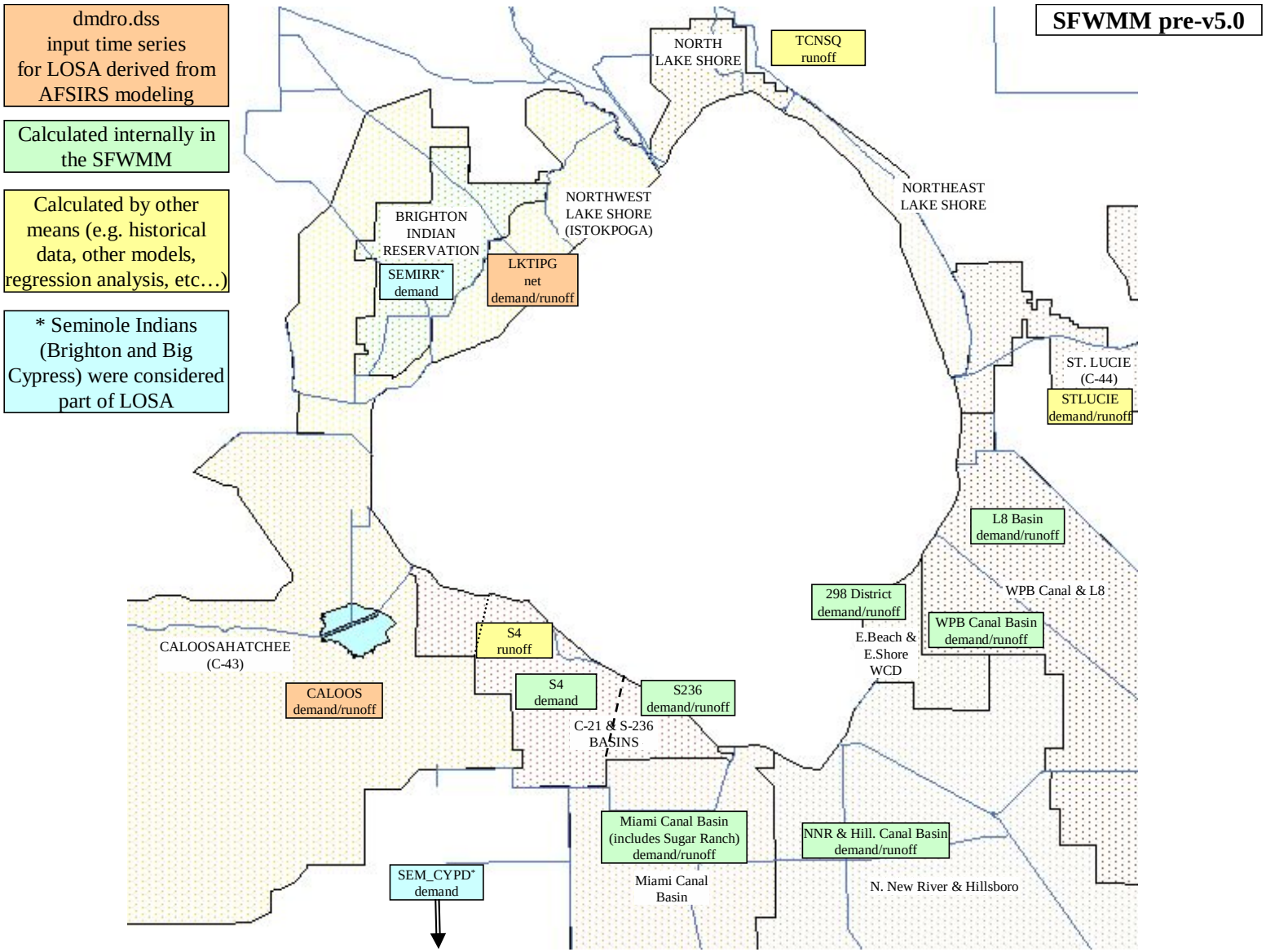

Figure 1 - Selected Lake Okeechobee Service Area, Seminole Tribe and LOK Inflow Basins, SFWMM pre-v5.0

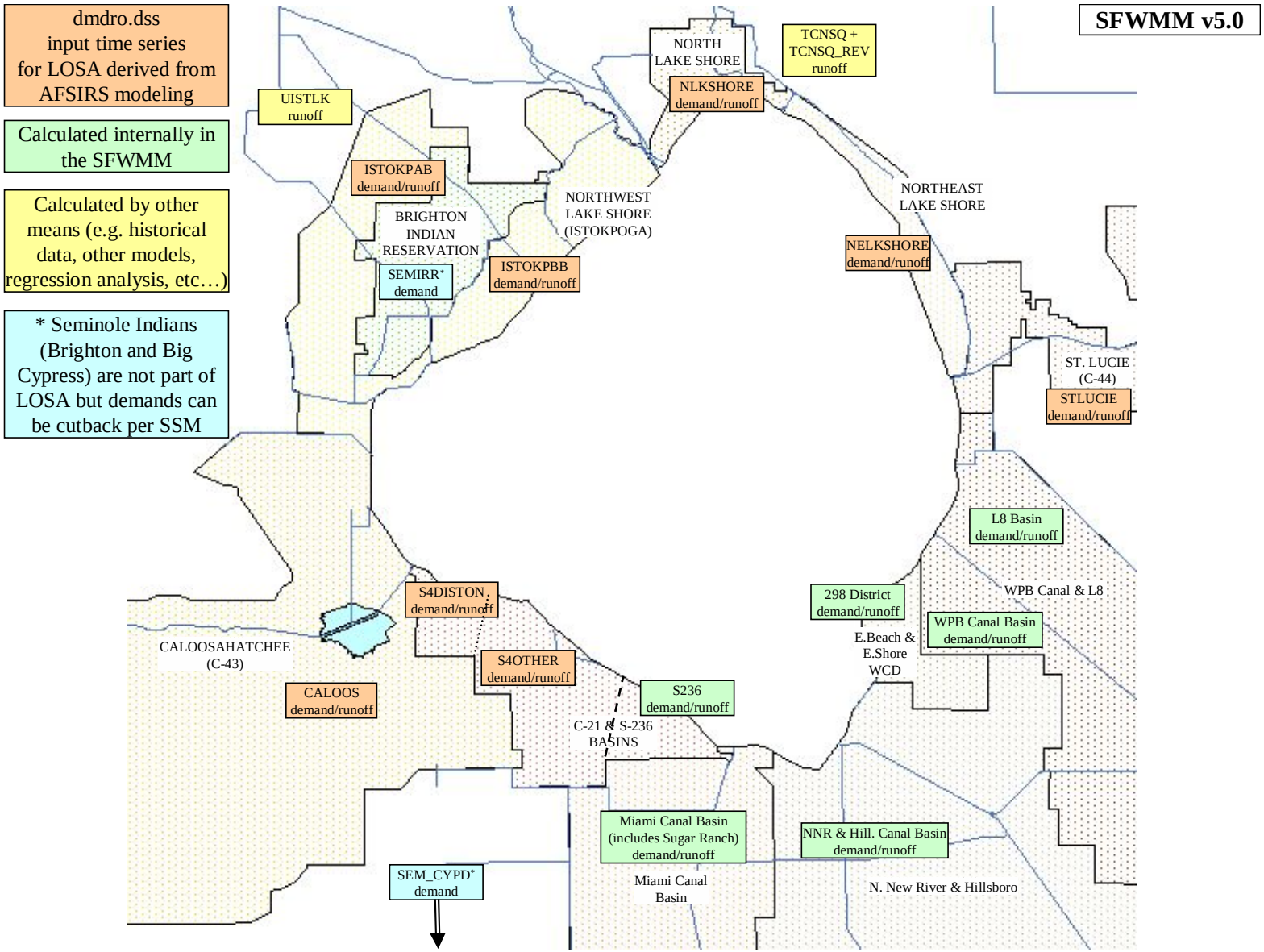

Figure 2 - Selected Lake Okeechobee Service Area, Seminole Tribe and LOK Inflow Basins, SFWMM v5.0

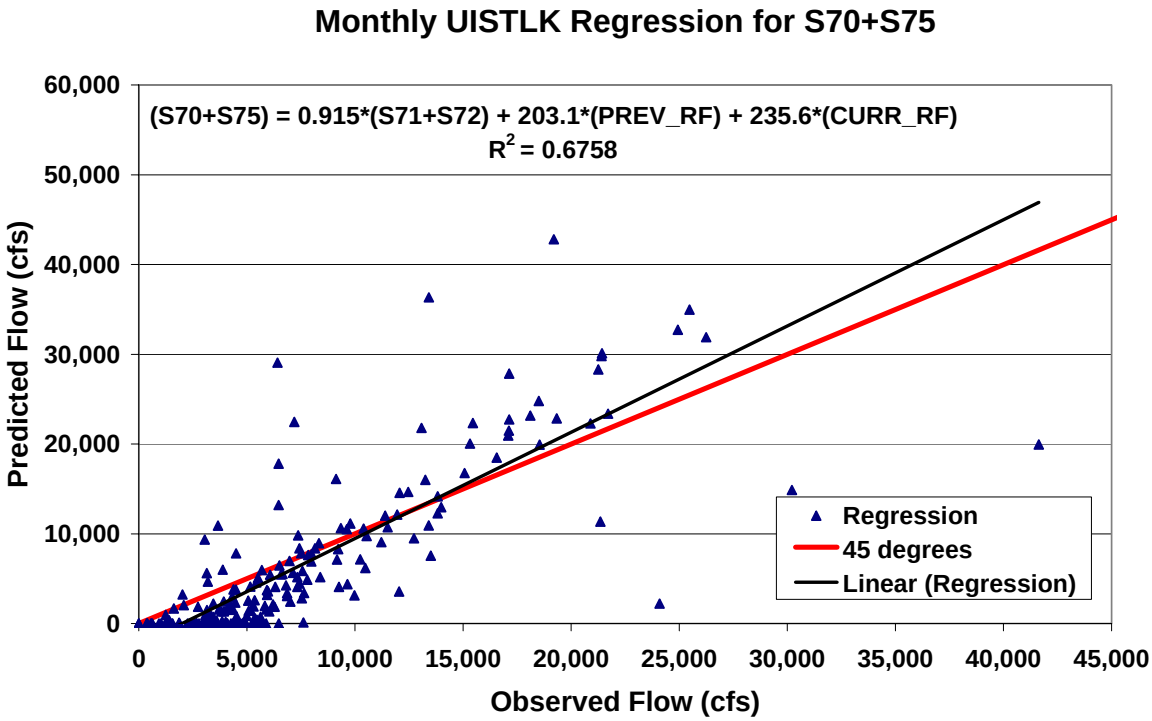

Figure 3 – UISLTK Regression Analysis (Monthly)

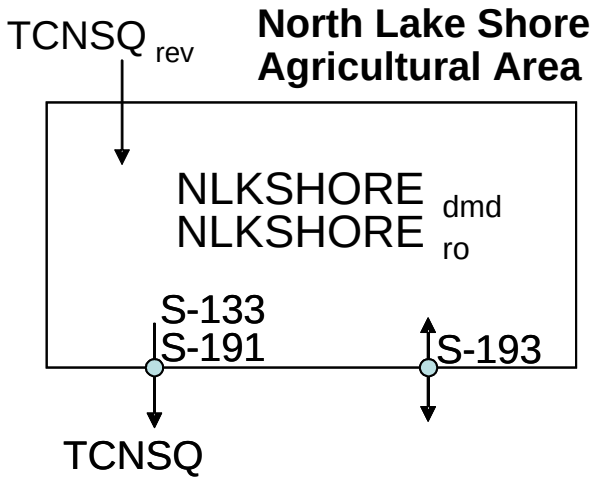

Figure 4 – Relationship between TCNSQrev, TCNSQ and NLKSHOREdmd/ro

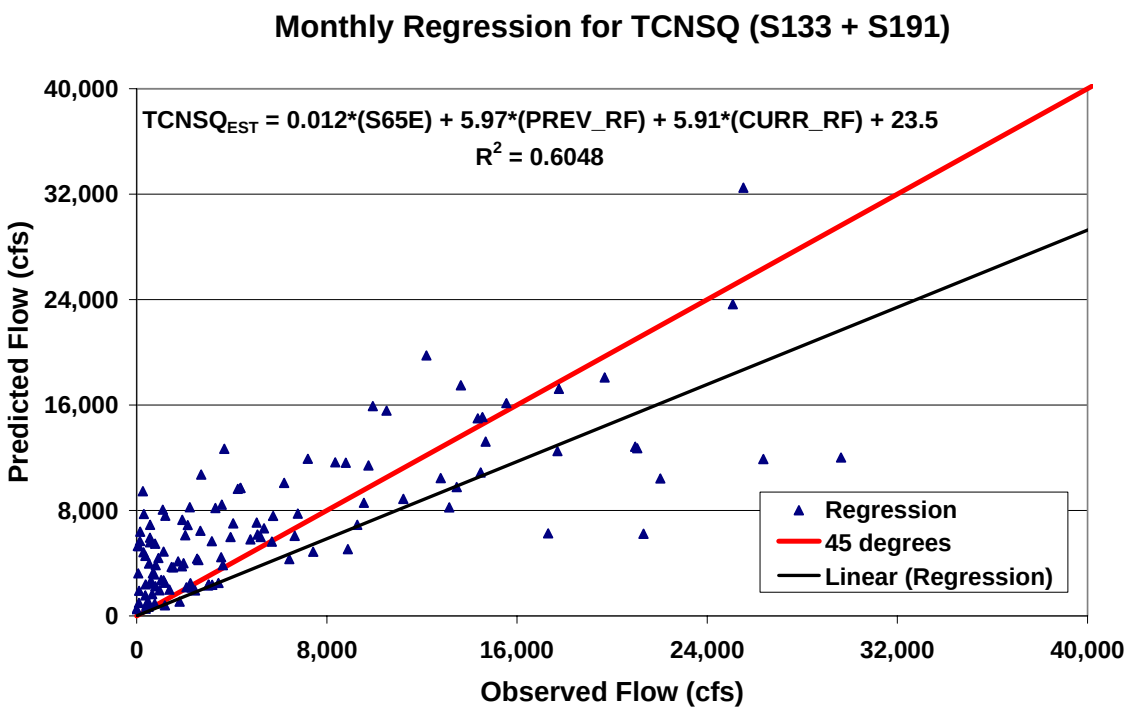

Figure 5 – TCNSQ Relationship Regression Analysis (Monthly)

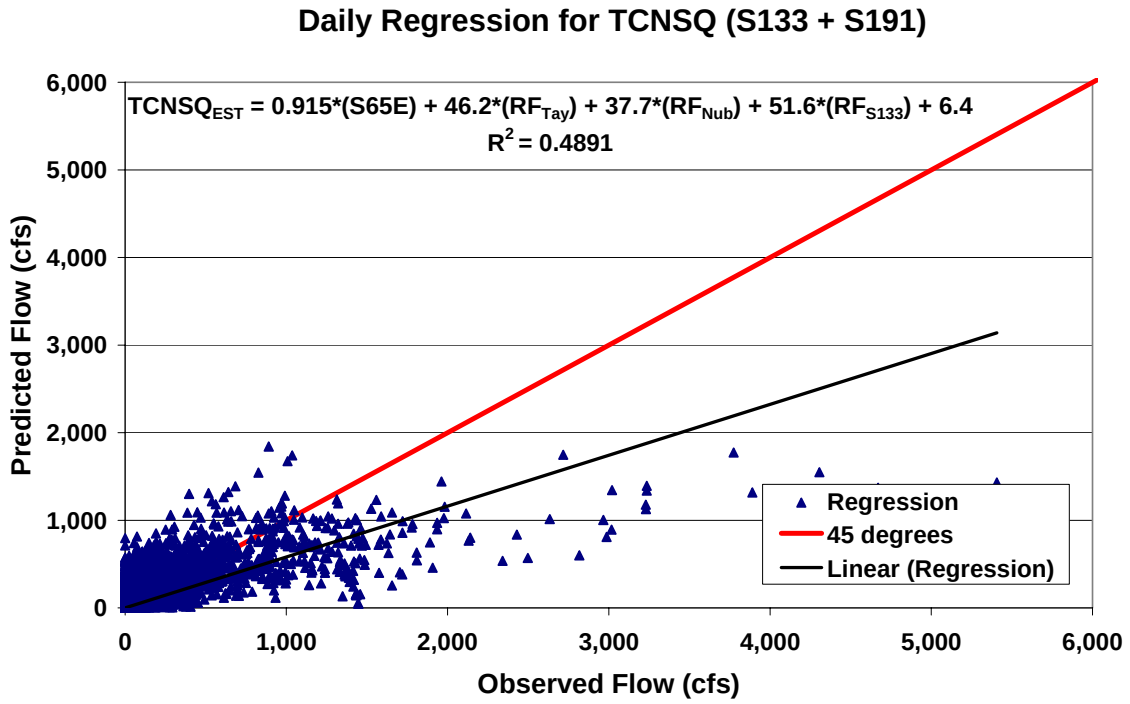

Figure 6 – TCNSQ Relationship Regression Analysis (Daily)

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